

# **X-ray Machine & Production**

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## **Intended Learning Outcomes ILO'S**

- ▶ Define radiation.
- ▶ Identify types and properties of radiation.
- ▶ Define roentgen rays.
- ▶ Discuss properties of roentgen rays
- ▶ Discuss production of x-rays
- ▶ Identify different components of x-ray machine and their functions.

# Roentgen Rays

## Roentgen Rays

### X-rays are:

- ▶ Pure energy units.
- ▶ Belonging to the electromagnetic spectrum.
- ▶ Have a very short wavelength.
- ▶ Can produce images of body tissues.

### Properties:

- Special properties
- General properties

# Special Properties of Roentgen Rays

1

- They have a very short wavelength ( $\lambda$ ).  
( $0.1 \text{ \AA}^\circ$ )

Shorter wave length ----- Increase power of penetration.

## Remember

**Power of penetration depends on several factors:**

1. Wavelength.
2. Atomic number of radiographed object.
3. Thickness of radiographed object.
4. Density of radiographed object.

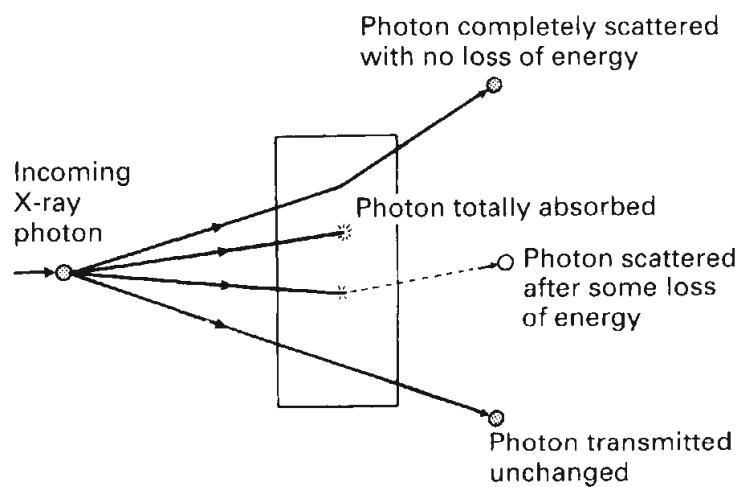
# Remember

Factor	Character	Penetration	Absorption
Wavelength	Shorter	Increase	Decrease
Atomic number	Decrease	Increase	Decrease
Thickness	Decrease	Increase	Decrease
Density	Decrease	Increase	Decrease

## Special Properties of Roentgen Rays

2

- They have a selective power of penetration and absorption.



## Special Properties of Roentgen Rays

3

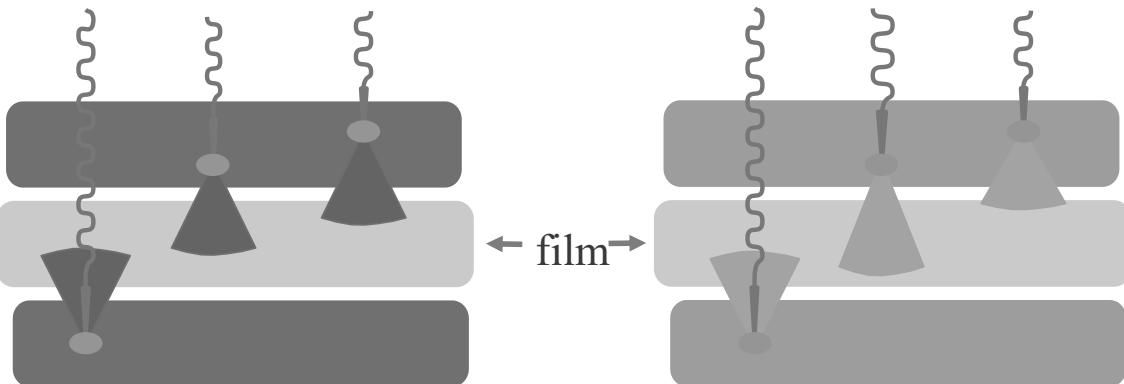
- ▶ They affect photographic film emulsion.  
Film X-Rays latent image processing visible image

## Special Properties of Roentgen Rays

4

- ▶ It can cause certain substance to fluoresce (emit radiation of longer wavelength).

## Light Emission



● = phosphor crystal

### Special Properties of Roentgen Rays

5

► They cause ionization of atoms.

6

► X-rays cause biologic changes in living cells.

## General Properties of Roentgen Rays

- ▶ They travel in straight lines, in a wave motion with the same speed of light.
- ▶ They are invisible, can't be smelled, heard or felt.

## General Properties of Roentgen Rays

- ▶ They have no charge and no mass.
- ▶ They can't be focused by a lens.
- ▶ Can't be reflected by a mirror.
- ▶ Can't be refracted in fluids.
- ▶ Can't be deviated by a magnet.
- ▶ **Can only be deflected.**

# Production of X-Rays

## Production of X-Rays

### Principle:

**In x-ray machine we need:**

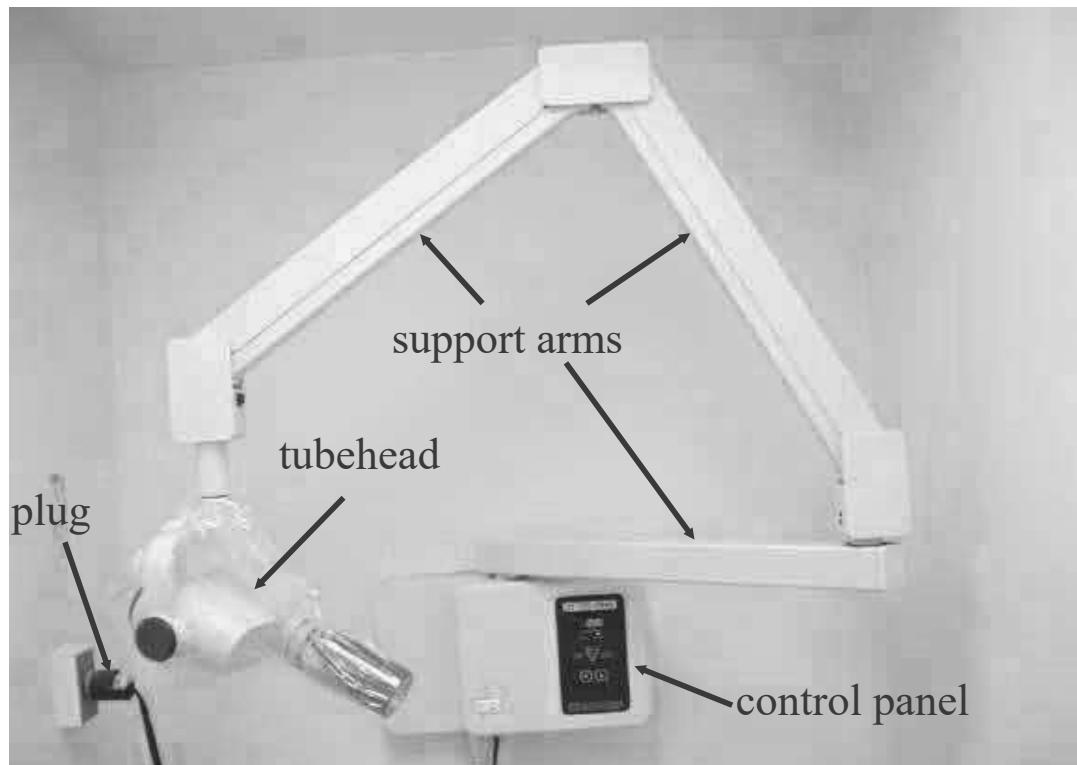
- Source of electrons (cathode filament)
- Generating system to accelerate the electrons (transformers).
- Anode's target ( for sudden stoppage)

# X- Ray Machine

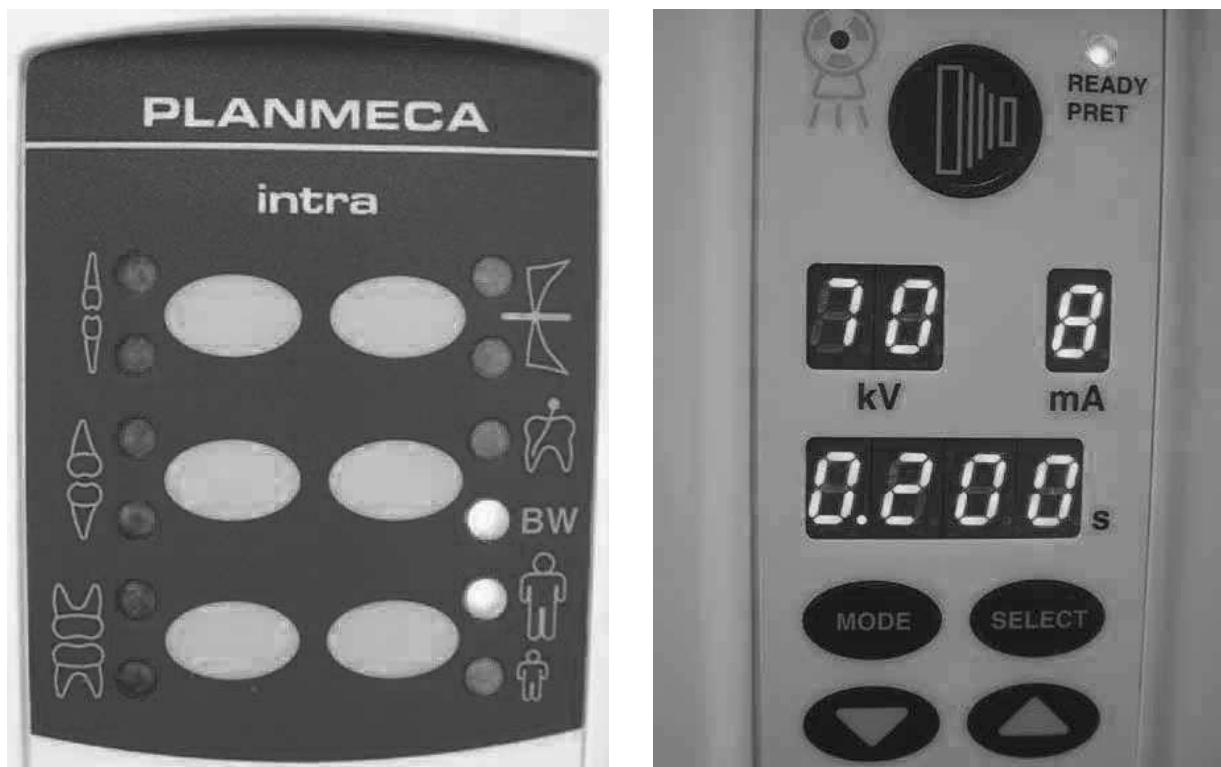
## X-Ray Machine

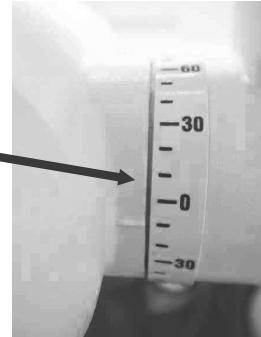
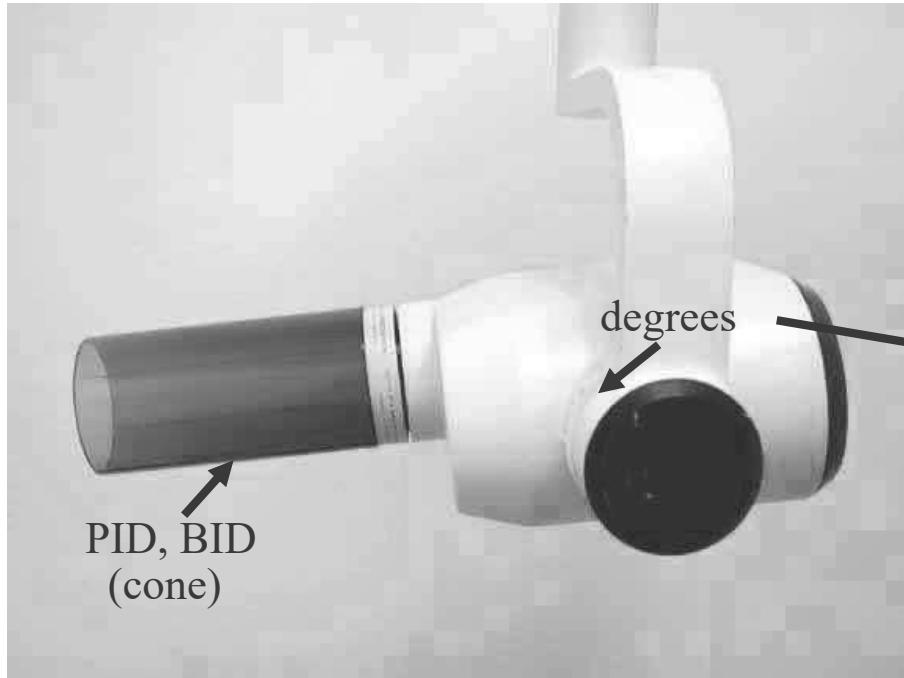
- 1.The tube-head.
- 2.The control panel & timer.
- 3.The adjusting arms.





## Control Panel



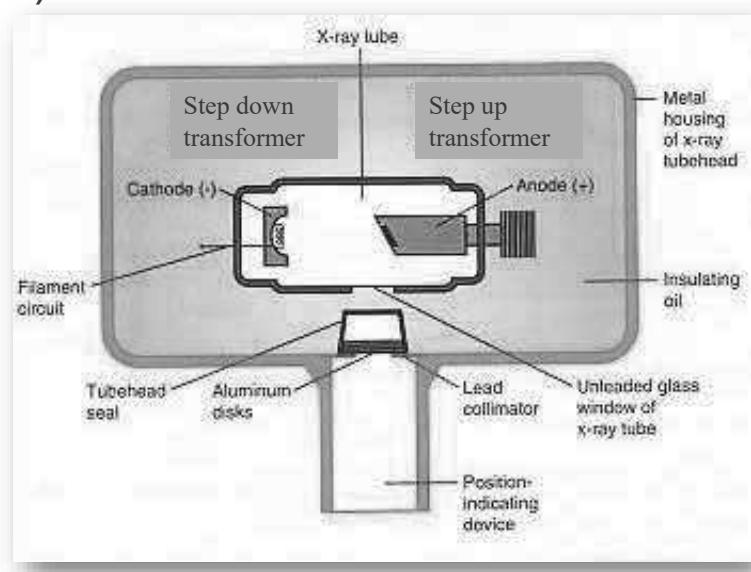


PID = position indicating device  
BID = beam indicating device

## Tube-head

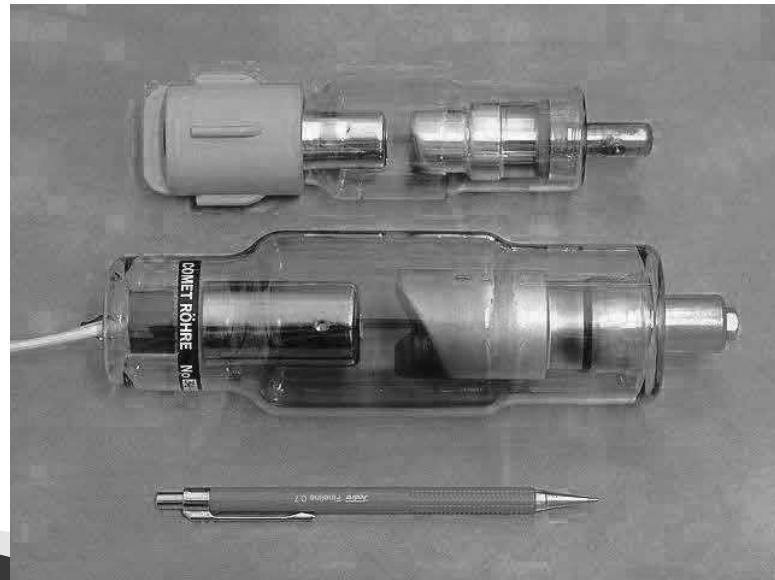
The tube-head include the following:

- ▶ The x-ray tube (main part)
- ▶ Transformers
- ▶ Insulating oil
- ▶ Metal housing
- ▶ Accessories



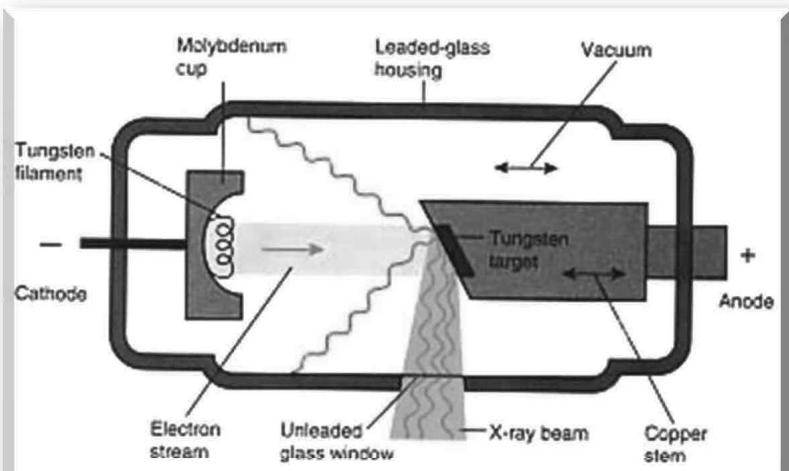
# X-ray Tube

- ▶ It is an evacuated glass tube, with two electrodes extending in two opposite directions which are the cathode and the anode.



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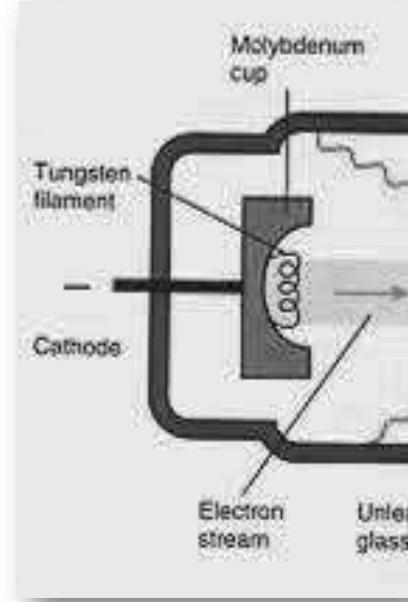
# X-ray Tube

## ► The cathode:

- (-ve) electrode of the tube.
- source of electrons.

## ► It is composed of :

- tungsten filament
- focusing cup



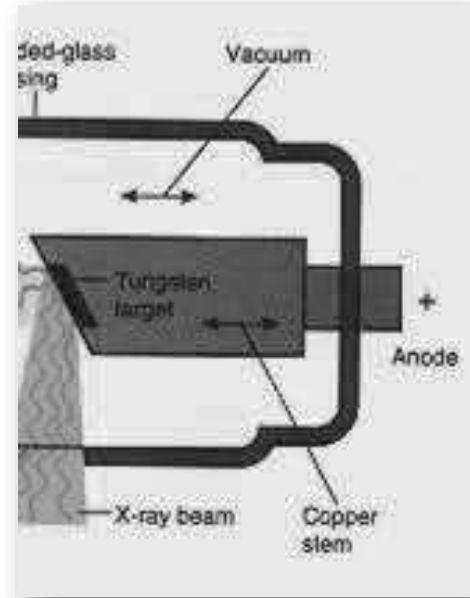
# X-ray Tube

## The anode:

- (+ve) electrode of the tube.

## It is composed of:

- target
- copper head
- copper arm



# Transformers

## A transformer:

- Used to increase or decrease the voltage in an electric circuit.

## Types:

- ▶ Step- down transformer (220 volt ----- 8 -12volt)
- ▶ Step- up transformer (8 -12 volt ----- 65000 volt)

## Step-Down Transformer

220 volt → 8-12volt

It's connected to the filament of the cathode

# Step-up Transformer

8-12 volt  $\longrightarrow$  65-70 KV

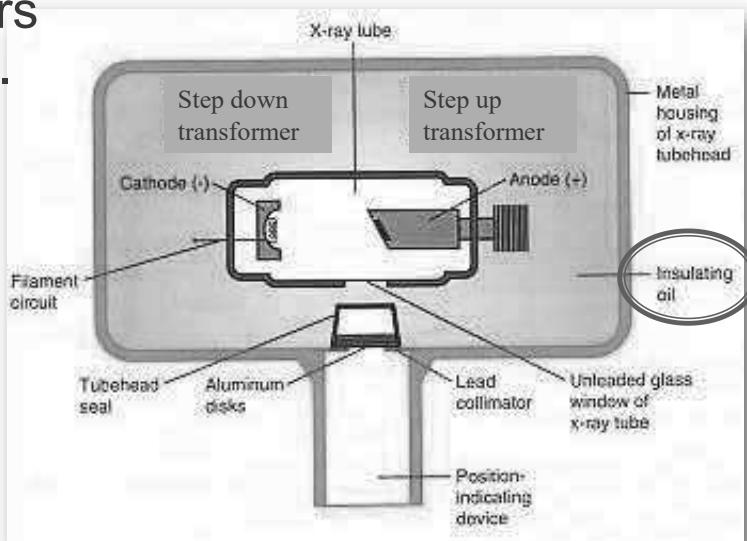
It's connected to copper arm  
(main circuit) of the anode

It surrounds the x-ray tube and transformers inside the tube head.

**Function:**

- ▶ An insulator against thermal shocks.

- ▶ Cools the anode
- ▶ Filters the x-ray beam

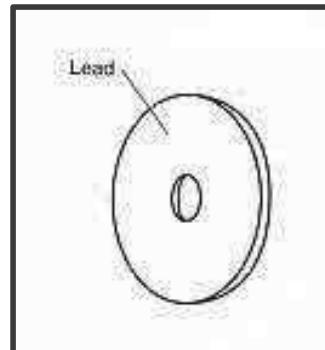


## The Metal Housing

- ▶ It is made of lead.
- ▶ It surrounds the glass tube, the insulating oil and transformers.
- ▶ It will absorb all the x-rays coming out of the generating system except for the useful beam.

## Accessories of the x-ray machine

1. **Filter.**
2. **Collimation.**
3. **Cone.**



# 1. Filter

## Added filters:

- ▶ Thin sheets of aluminum.

## Inherent filters:

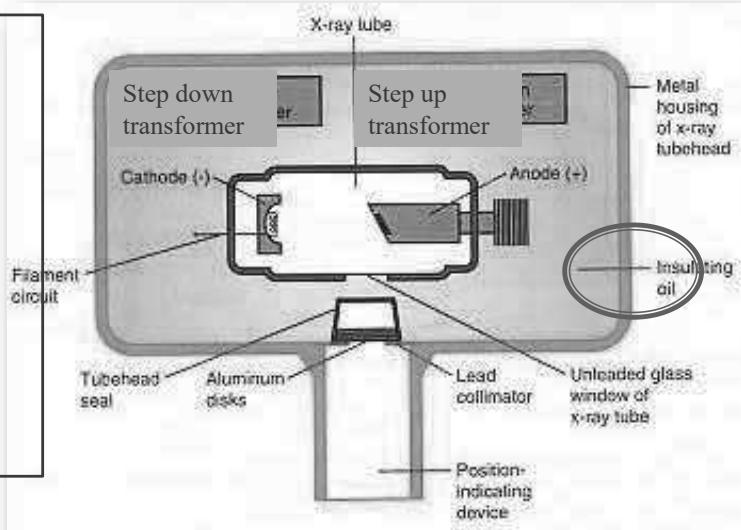
- ▶ Glass wall of x-ray tube
- ▶ Insulating oil
- ▶ The barrier material.

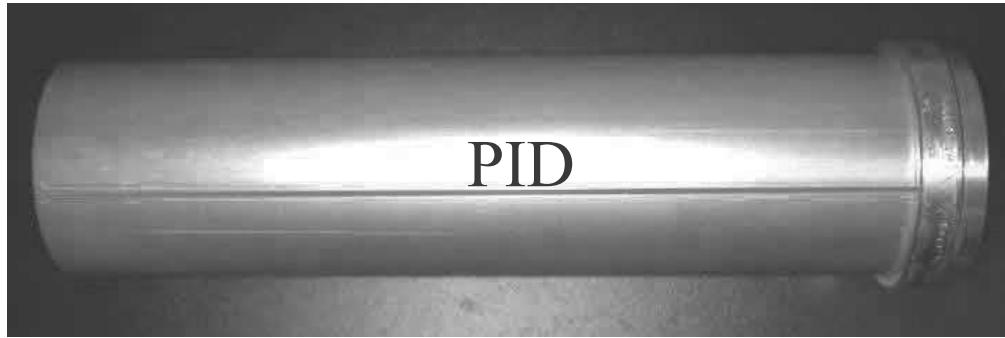
The total filtration of x-ray tube =  
added + inherent

# 1. Filter

## Inherent filters:

- ▶ Glass wall of x-ray tube
- ▶ Insulating oil
- ▶ The barrier material.





### Added filters:

- ▶ Thin sheets of aluminum.



## 1. Filter

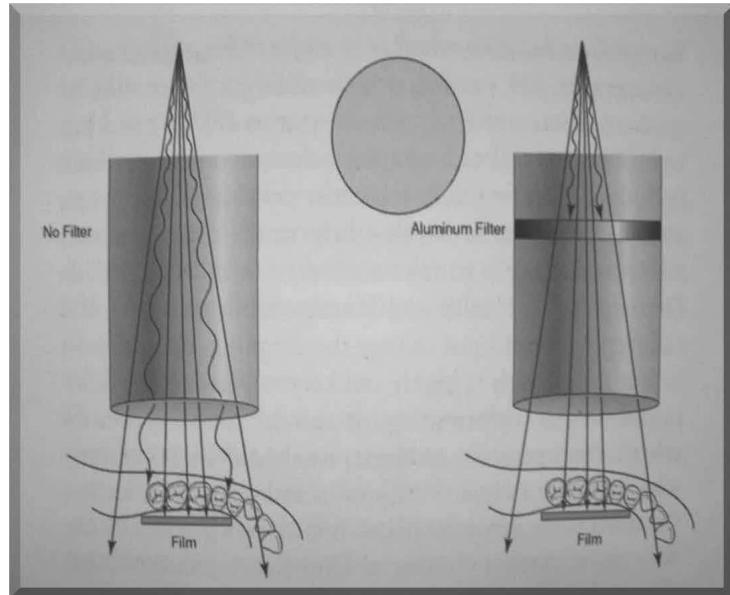
- ▶ It is thin sheet or disc of aluminum.
- ▶ Placed at the aperture of x-ray tube.
- ▶ In order to improve the quality of the beam.



# 1. Filter

## ▶ Function:

The x-ray beam is a heterogenous beam containing rays with longer and shorter wave length. The filter will remove rays with longer ( $\lambda$ ) and have low power of penetration.



## Remember

### Thickness:

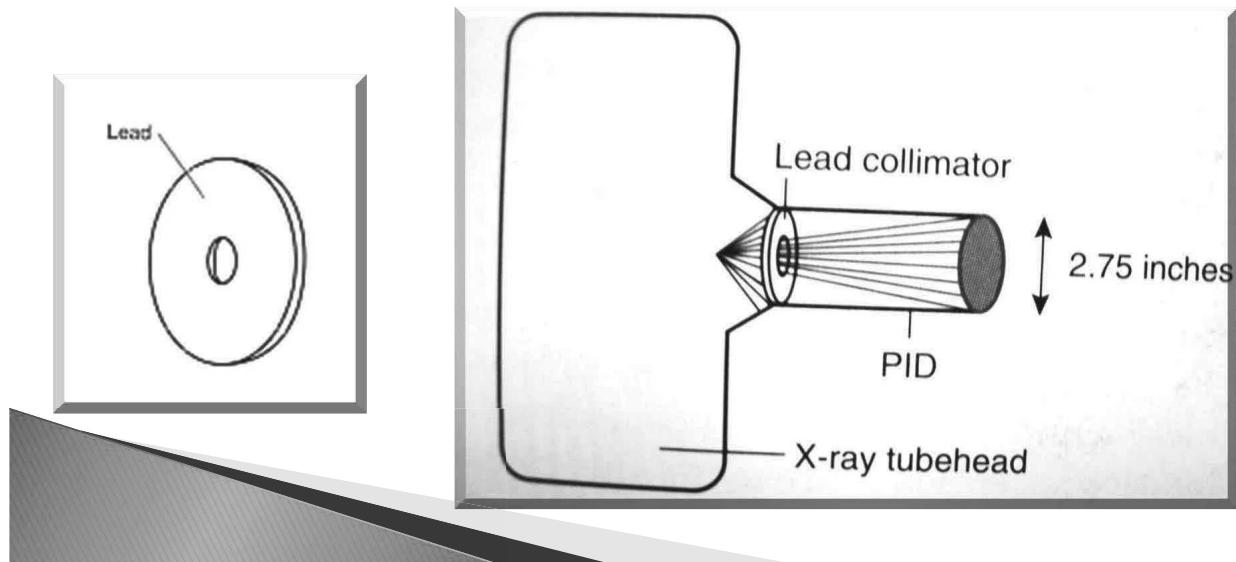
1.5 mm Al ----- 70 KVP

2.5 mm Al ----- ↑ 70 KVP

## 2. Collimator

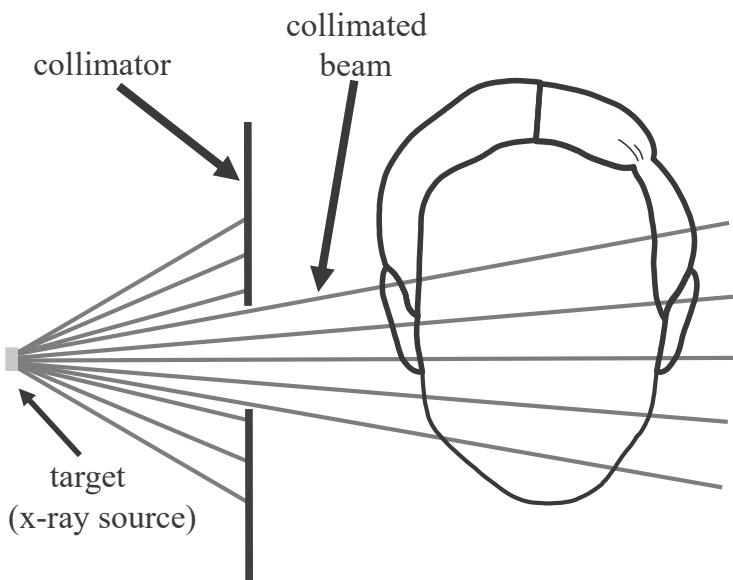
### Definition:

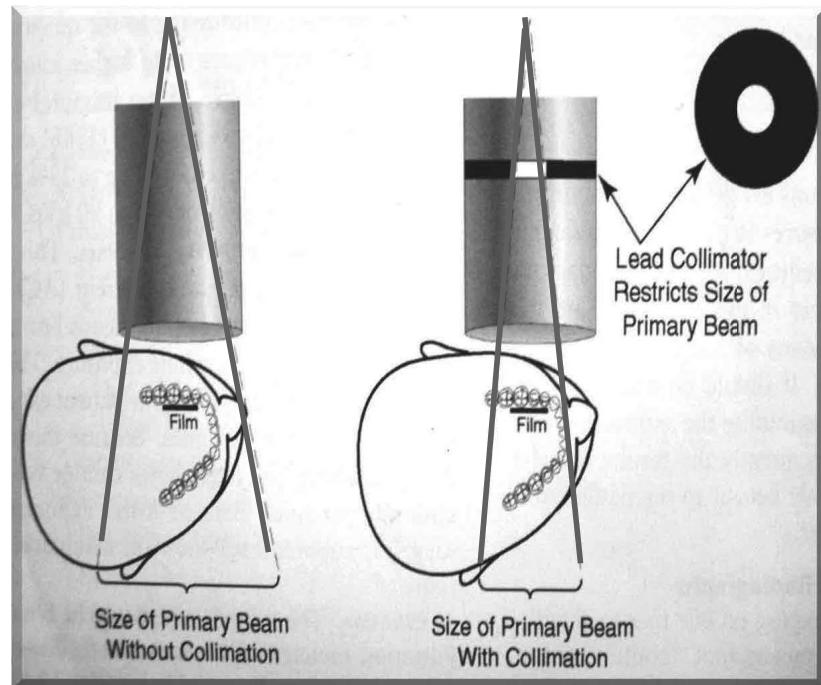
It is a device used to restrict the size of x-ray beam just to cover the film ( 2.75" in diameter).



## 2. Collimator

side view

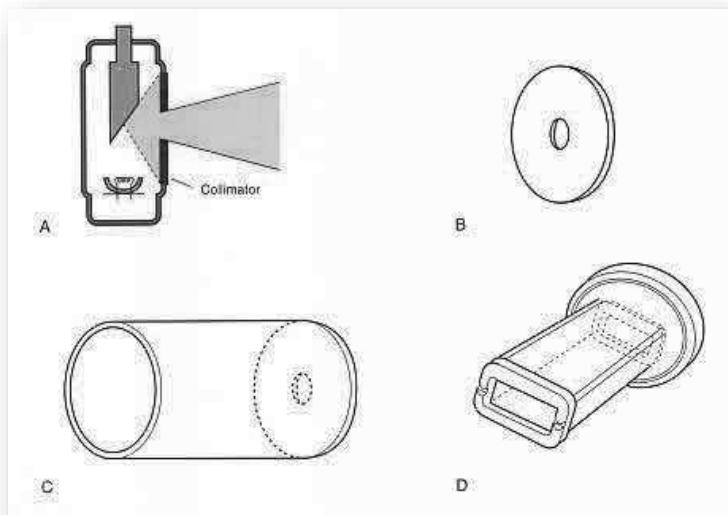




## 2. Collimator

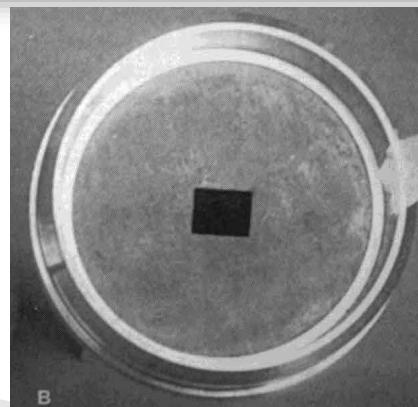
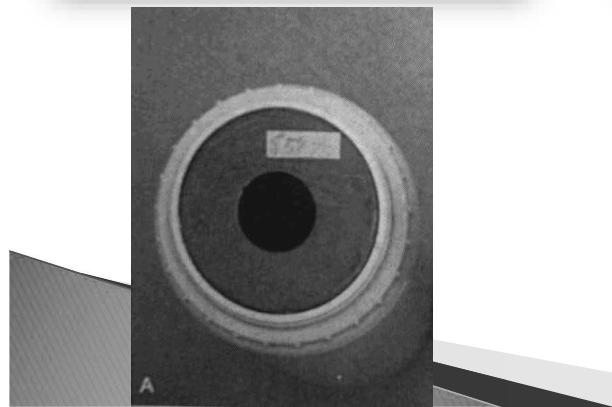
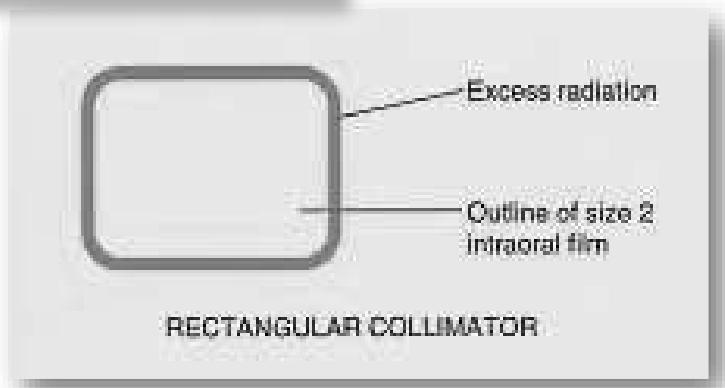
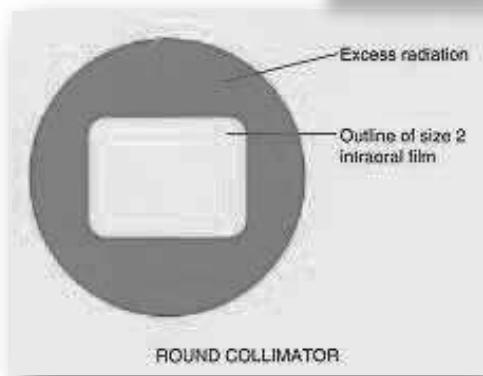
### Types:

- Diaphragm
- Tubular
- Rectangular

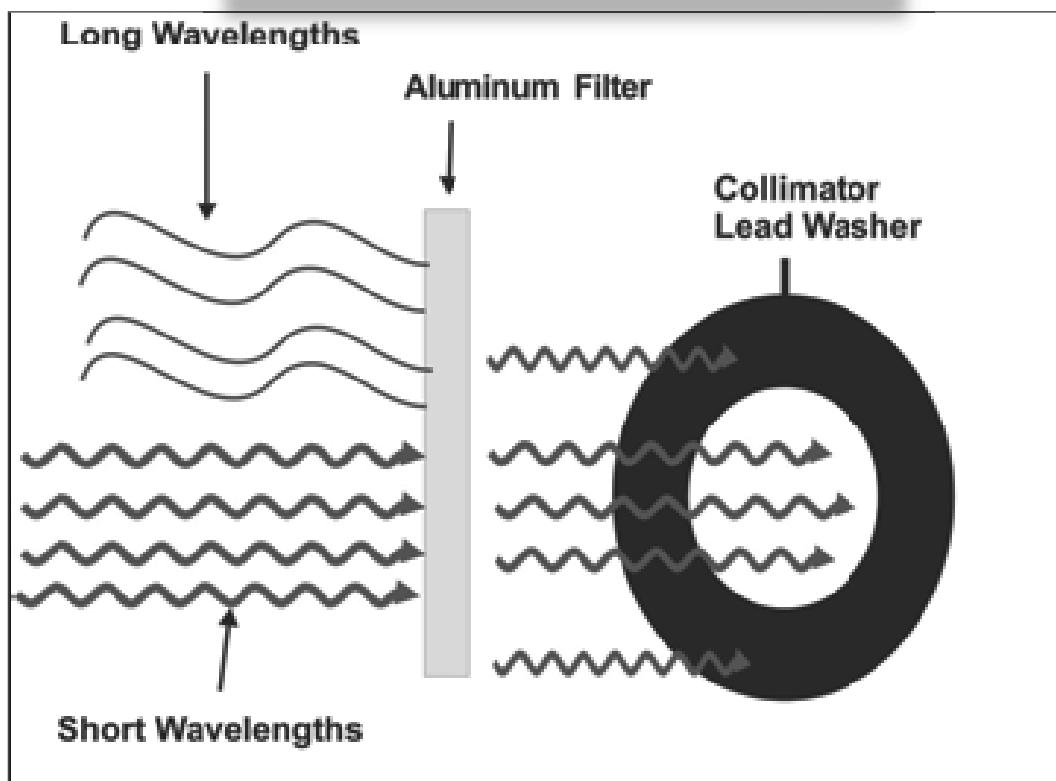




## 2. Collimator



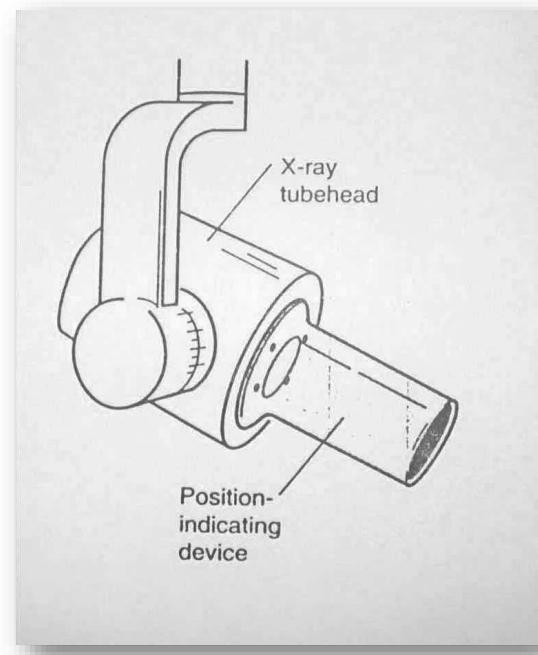
# Give Comment



## 3.Cone (PID)

Definition:

- fix the target-film distance.
- indicate the point of entry.
- delineate the direction of x-ray beam.



### 3.Cone (PID)

#### Classification:

According to composition:

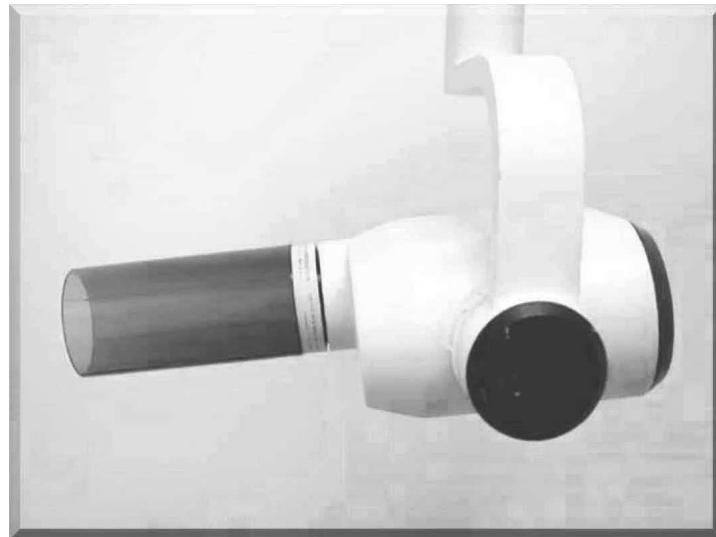
- Plastic or glass
- Metallic

According to shape:

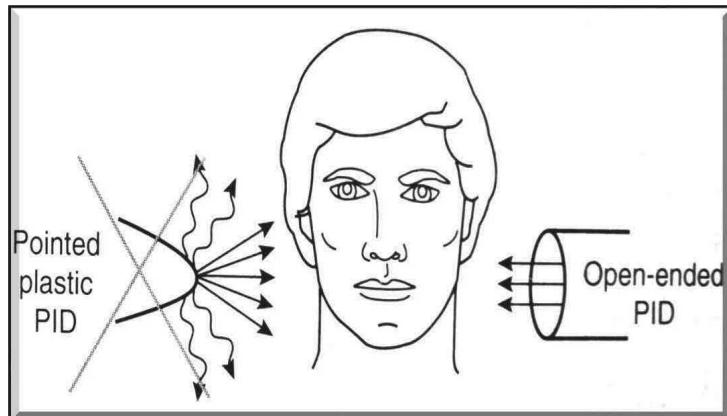
- Open end (cylindrical)
- Pointed end ( conical)

According to length:

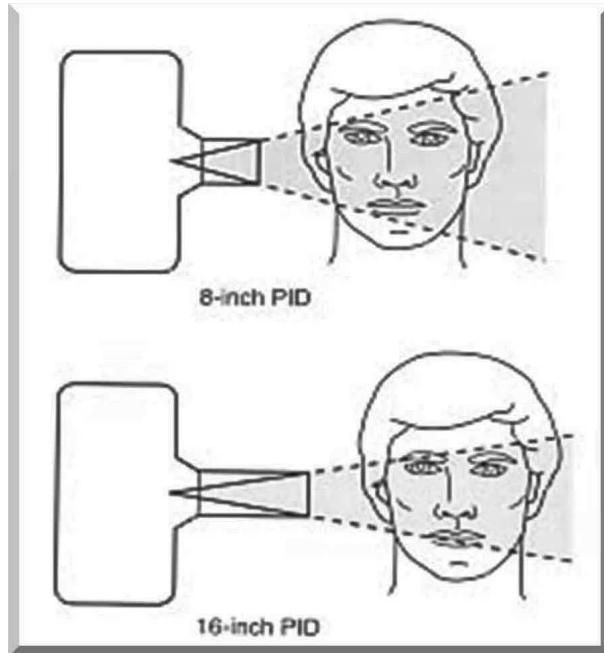
- Short (8")
- Long (16")



### 3.Cone (PID)



### 3.Cone (PID)



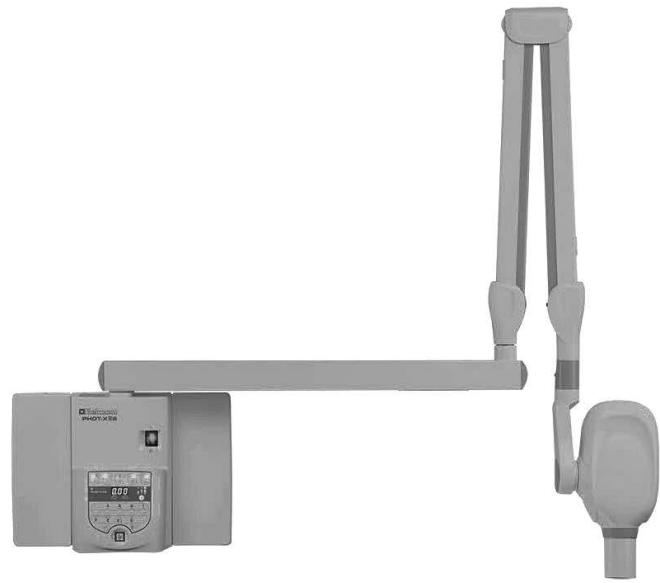
### Timer

#### Definition:

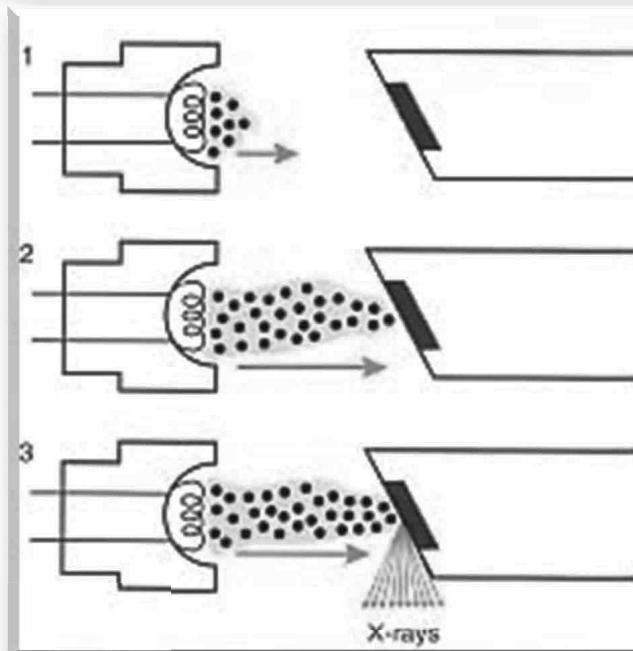
- control the exposure time.
- calibrated in fractions of seconds.

#### Types:

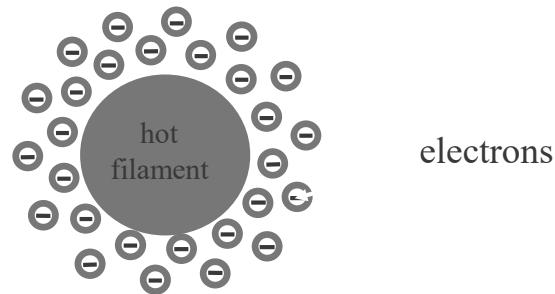
1. Automatic (electronic) timers:
  - Direct ( immediate).
  - Delayed (7-9 seconds).
2. Manual timers.



## Production of x-rays



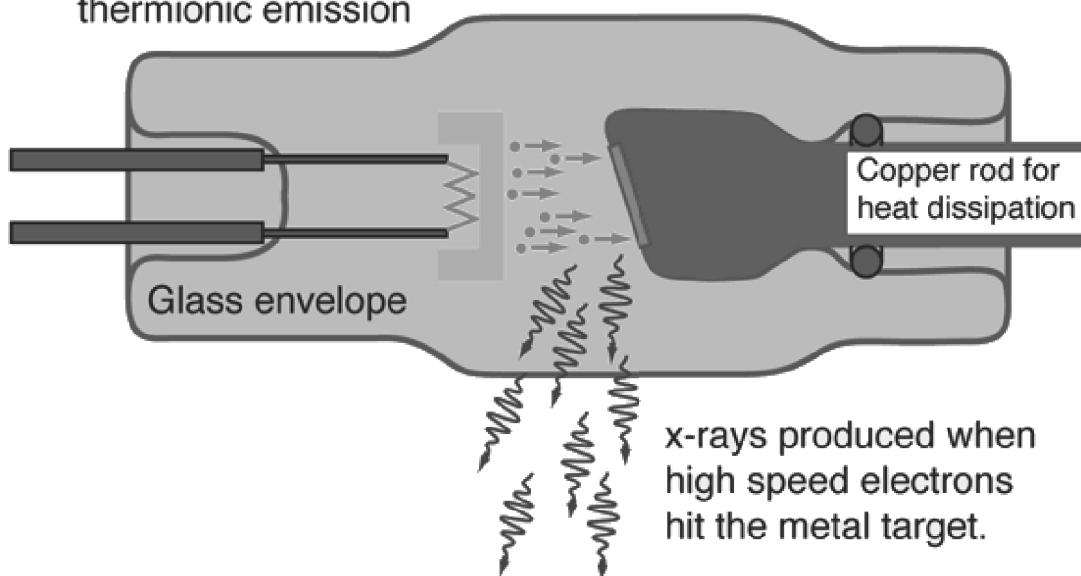
# Production of x-rays



## Thermionic Emission

Heated filament  
emits electrons by  
thermionic emission

Electrons are accelerated  
by a high voltage.



# X-ray Production

- Bremmstrahlung (70%)  
(German word of braking radiation)
- Characteristic (30%)

## Parameters of X-ray Machine

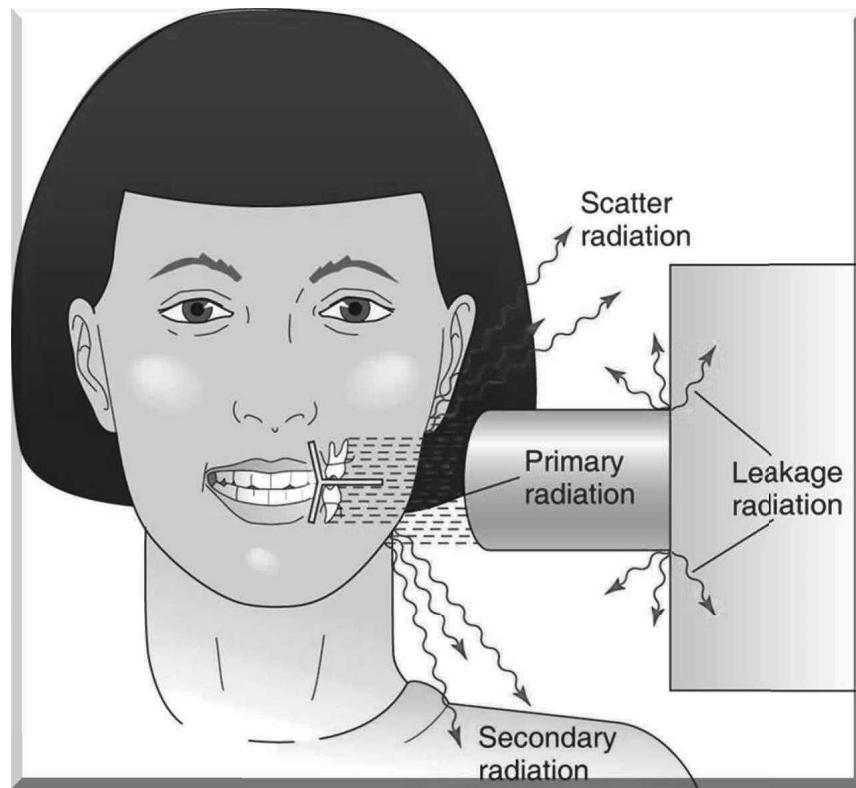
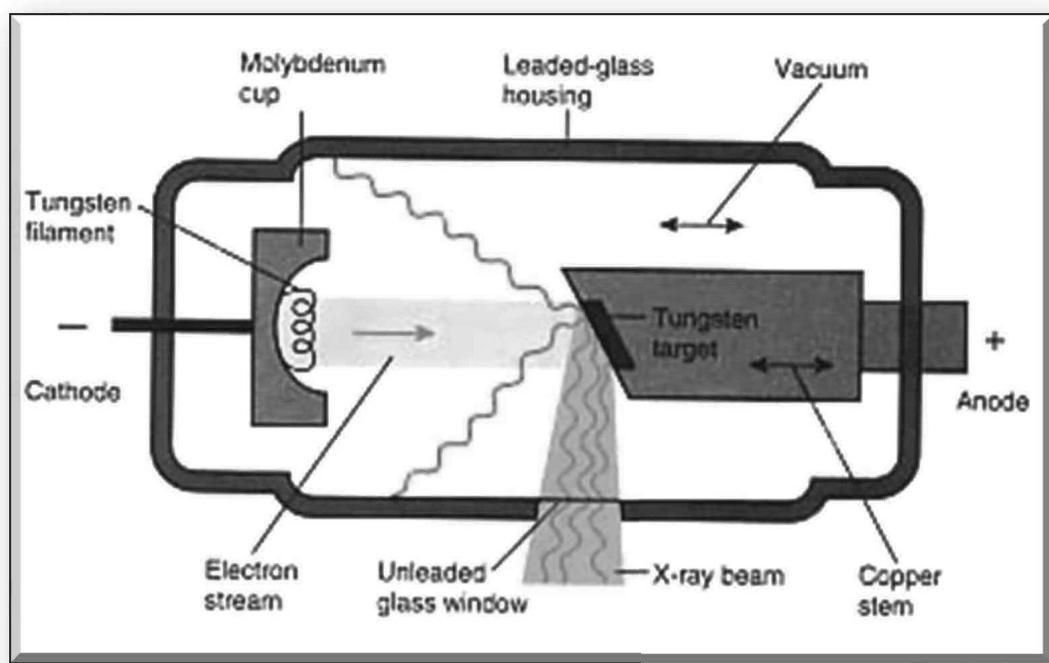
K.V. 60 -70 (It may reach 90)

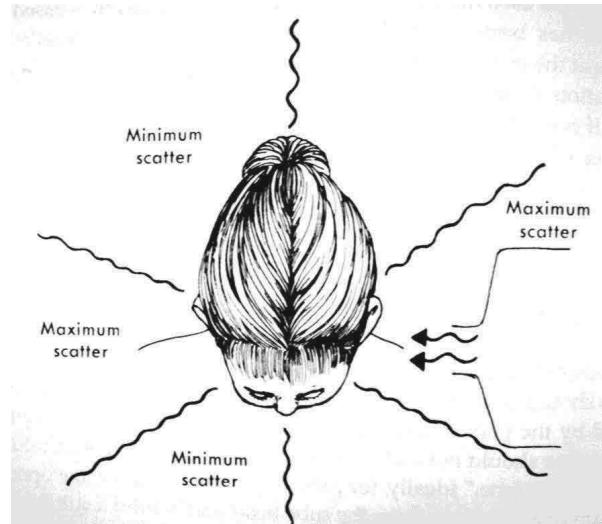
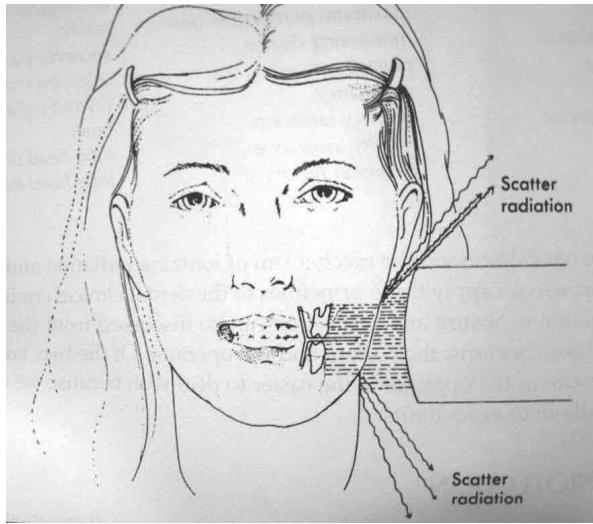
m.A. 8 -12

# Terminology

## Terminology

- ▶ Primary radiation.
- ▶ Useful beam.
- ▶ Secondary radiation.
- ▶ Soft radiation.
- ▶ Hard radiation.
- ▶ Scattering.
- ▶ Absorption.
- ▶ Attenuation.
- ▶ Ionization.





## Scattered radiation

61

# Any Question?

